

## Claims

[c1] What is claimed is:

1. A non-volatile memory positioned on a substrate of a semiconductor wafer, the non-volatile memory comprising:
  - a main memory array region comprising:
    - at least one main memory cell, the main memory cell comprising a main source and a main drain positioned in the substrate of the semiconductor wafer;
    - at least one main bit line, the main bit line being electrically connected to the main drain of the main memory cell; and
    - at least one main ground line, the main ground line being electrically connected to the main source of the main memory cell;
  - a redundant memory array region connected to the main memory array region, the redundant memory array region comprising:
    - at least one redundant memory cell, the redundant memory cell comprising a redundant source and a redundant drain positioned in the substrate of the semiconductor wafer;
    - at least one redundant bit line, the redundant bit line being electrically connected to the redundant drain of the redundant memory cell; and
    - at least one redundant ground line, the redundant ground line being electrically connected to the redundant source of the redundant memory cell; and
  - a common source used as the main source and the redundant source formed between the main memory array region and the redundant memory array region.
2. The non-volatile memory of claim 1 further comprising a peripheral circuit region having:
  - a main memory ground line decoder electrically connected to the main ground lines in the main memory array region;
  - a redundant memory ground line decoder electrically connected to the redundant ground lines in the redundant memory array region; and
  - at least two signal pass lines, two ends of each of the signal pass lines being electrically connected to the main memory ground line decoder and the redundant memory ground line decoder, respectively.

[c3] 3. The non-volatile memory of claim 2 wherein the common source is electrically connected to a common ground line, and when the main memory ground line decoder addresses the common ground line, the main memory ground line decoder passes a signal to the redundant memory ground line decoder through the signal pass line to determine a potential of the common ground line and to generate an open-circuit between the common ground line and the redundant memory ground line decoder, and when the redundant memory ground line decoder addresses the common ground line, the redundant memory ground line decoder passes a signal to the main memory ground line decoder through the other signal pass line to determine a potential of the common ground line and to generate an open-circuit between the common ground line and the main memory ground line decoder.

[c4] 4. The non-volatile memory of claim 3 wherein a sub-decoder of the main memory ground line decoder is electrically connected to the common ground line and comprises a three-input NAND gate having three inputs for receiving an address signal, a first inverter having a first input electrically connected to an output of the three-input NAND gate, and a first tri-state inverter having a control end electrically connected to an output of a four-input NAND gate, the four-input NAND gate having four inputs and being formed in a sub-decoder of the redundant memory ground line decoder for receiving an address signal and a corresponding signal, the sub-decoder of the redundant memory ground line decoder being electrically connected to the common ground line and further comprising a second inverter and a second tri-state inverter, an input of the second inverter being electrically connected to an output of the four-input NAND gate, a control end of the second tri-state inverter being electrically connected to an output of the three-input NAND gate.

[c5] 5. The non-volatile memory of claim 2 wherein the common source is electrically connected to a common ground line, and when the main memory ground line decoder addresses the common ground line, the main memory ground line decoder passes a signal to the redundant memory ground line decoder through the signal pass line so as to select the sub-decoders connected to the common ground line and cause the selected sub-decoders to generate an equal-

potential output, and when the redundant memory ground line decoder addresses the common ground line, the redundant memory ground line decoder passes a signal to the main memory ground line decoder through the signal pass line to select the sub-decoders electrically connected to the common ground line and generate an equal-potential output.

[c6] 6. The non-volatile memory of claim 5 wherein a sub-decoder of the main memory ground line decoder is electrically connected to the common ground line and comprises a three-input NAND gate having three inputs for receiving an address signal, a first NAND gate having an input electrically connected to an output of the three-input NAND gate and the other input electrically connected to an output of a four-input NAND gate, and a first inverter, the four-input NAND gate having four inputs and being formed in a sub-decoder of the redundant memory ground line decoder for receiving an address signal and a corresponding signal, the sub-decoder of the redundant memory ground line decoder being electrically connected to the common ground line and further comprising a second two-input NAND gate and a second inverter, an input of the second two-input NAND gate being electrically connected to an output of the four-input NAND gate, the other input of the second two-input NAND gate being electrically connected to an output of the three-input NAND gate in a sub-decoder of the main memory ground line decoder.

[c7] 7. The non-volatile memory of claim 1 wherein the non-volatile memory has a virtual ground array structure.

[c8] 8. A non-volatile memory positioned on a substrate of a semiconductor wafer, the non-volatile memory comprising:  
a main memory array region comprising:  
at least one main memory cell, the main memory cell comprising a main source and a main drain positioned in the substrate of the semiconductor wafer;  
at least one main bit line, the main bit line being electrically connected to the main drain of the main memory cell; and  
at least one main ground line, the main ground line being electrically connected to the main source of the main memory cell;

a redundant memory array region connected to the main memory array region, the redundant memory array region comprising:

at least one redundant memory cell, the redundant memory cell comprising a redundant source and a redundant drain positioned in the substrate of the semiconductor wafer;

at least one redundant bit line, the redundant bit line being electrically connected to the redundant drain of the redundant memory cell; and

at least one redundant ground line, the redundant ground line being electrically connected to the redundant source of the redundant memory cell; and

a common drain used as the main drain and the redundant drain formed between the main memory array region and the redundant memory array region.

[c9] 9. The non-volatile memory of claim 8 further comprising a peripheral circuit region having:

a main memory bit line decoder electrically connected to the main bit lines in the main memory array region;

a redundant memory bit line decoder electrically connected to the redundant bit lines in the redundant memory array region; and

at least two signal pass lines, two ends of each of the signal pass lines being electrically connected to the main memory bit line decoder and the redundant memory bit line decoder, respectively.

[c10] 10. The non-volatile memory of claim 9 wherein the common drain is electrically connected to a common bit line, and when the main memory bit line decoder addresses the common bit line, the main memory bit line decoder passes a signal to the redundant memory bit line decoder through the signal pass line to determine a potential of the common bit line and to generate an open-circuit between the common bit line and the redundant memory bit line decoder, and when the redundant memory bit line decoder addresses the common bit line, the redundant memory bit line decoder passes a signal to the main memory bit line decoder through the other signal pass line to determine a potential of the common bit line and to generate an open-circuit between the common bit line and the main memory bit line decoder.

[c11] 11. The non-volatile memory of claim 10 wherein a sub-decoder of the main memory bit line decoder is electrically connected to the common bit line and comprises a three-input NAND gate having three inputs for receiving an address signal, a first inverter having an input electrically connected to an output of the three-input NAND gate, and a first tri-state inverter having a control end electrically connected to an output of a four-input NAND gate, the four-input NAND gate having four inputs and being formed in a sub-decoder of the redundant memory bit line decoder for receiving an address signal and a corresponding signal, the sub-decoder of the redundant memory bit line decoder being electrically connected to the common bit line and further comprising a second inverter and a second tri-state inverter, an input of the second inverter being electrically connected to an output of the four-input NAND gate, an input of the second tri-state inverter being electrically connected to an output of the three-input NAND gate in a sub-decoder of the main memory bit line decoder.

[c12] 12. The non-volatile memory of claim 9 wherein the common drain is electrically connected to a common bit line, and when the main memory bit line decoder addresses the common bit line, the main memory bit line decoder passes a signal to the redundant memory bit line decoder through the signal pass line so as to select the sub-decoders electrically connected to the common bit line and generate an equal-potential output, and when the redundant memory bit line decoder addresses the common bit line, the redundant memory bit line decoder passes a signal to the main memory bit line decoder through the signal pass line to select the sub-decoders electrically connected to the common bit line and generate an equal-potential output.

[c13] 13. The non-volatile memory of claim 12 wherein the sub-decoder of the main memory bit line decoder is electrically connected to the common bit line and comprises a three-input NAND gate having three inputs for receiving an address signal, a first NAND gate having an input electrically connected to an output of the three-input NAND gate and the other input electrically connected to an output of a four-input NAND gate, and a first inverter, the four-input NAND gate having four inputs and being formed in a sub-decoder of the redundant

memory bit line decoder for receiving an address signal and a corresponding signal, the sub-decoder of the redundant memory bit line decoder being electrically connected to the common bit line and further comprising a second two-input NAND gate and a second inverter, an input of the second two-input NAND gate being electrically connected to an output of the four-input NAND gate, the other input of the second two-input NAND gate being electrically connected to an output of the three-input NAND gate in a sub-decoder of the main memory bit line decoder.

- [c14] 14. The non-volatile memory of claim 8 wherein the non-volatile memory has a virtual ground array structure.
- [c15] 15. A non-volatile memory positioned on a substrate of a semiconductor wafer, the non-volatile memory comprising:
  - a main memory array region comprising at least one main memory cell;
  - a redundant memory array region connected to the main memory array region, the redundant memory array region comprising at least one redundant memory cell; and
  - a common doped region positioned between the main memory array region and the redundant memory array region and simultaneously electrically connected the main memory cell and the redundant memory cell that are adjacent to the common doped region.
- [c16] 16. The non-volatile memory of claim 15 wherein both the main memory cell and the redundant memory cell comprise a source and a drain positioned in the substrate of the semiconductor wafer, and the common doped region is used as a common source of the main memory cell and the redundant memory cell that are adjacent to the common doped region.
- [c17] 17. The non-volatile memory of claim 15 wherein both the main memory cell and the redundant memory cell comprise a source and a drain positioned in the substrate of the semiconductor wafer, and the common doped region is used as a common drain of the main memory cell and the redundant memory cell that are adjacent to the common doped region.

[c18] 18. A controlling method of a non-volatile memory having a virtual ground array structure, the non-volatile memory comprising a main memory array region, a redundant memory array region connected to the main memory array region, a peripheral circuit region, and a common doped region positioned between the main memory array region and the redundant memory array region, the main memory array region comprising at least one main memory cell, a main bit line electrically connected to a drain of the main memory cell, and a main ground line electrically connected to a source of the main memory cell, the redundant memory array region comprising at least one redundant memory cell, a redundant bit line electrically connected to a drain of the redundant memory cell, and a redundant ground line electrically connected to a source of the redundant memory cell, the peripheral circuit region comprising a main memory ground line decoder electrically connected to the main ground lines in the main memory array region, a redundant memory ground line decoder electrically connected to the redundant ground lines in the redundant memory array region, and at least one first signal pass line, at least one second signal pass line, and two ends of each of the signal pass lines being electrically connected to the main memory ground line decoder and the redundant memory ground line decoder respectively, the controlling method comprising:  
while the main memory ground line decoder addresses a common ground line electrically connected to the common doped region, the main memory ground line decoder passes a signal to the redundant memory ground line decoder through the first signal pass line to determine a potential of the common ground line and to generate an open-circuit between the common ground line and the redundant memory ground line decoder; and  
while the redundant memory ground line decoder addresses the common ground line, the redundant memory ground line decoder passes a signal to the main memory ground line decoder through the second signal pass line to determine a potential of the common ground line and to generate an open-circuit between the common ground line and the main memory ground line decoder.

[c19] 19. A controlling method of a non-volatile memory having a virtual ground array

structure, the non-volatile memory comprising a main memory array region, a redundant memory array region connected to the main memory array region, a peripheral circuit region, and a common doped region positioned between the main memory array region and the redundant memory array region, the main memory array region comprising at least one main memory cell, a main bit line electrically connected to a drain of the main memory cell, and a main ground line electrically connected to a source of the main memory cell, the redundant memory array region comprising at least one redundant memory cell, a redundant bit line electrically connected to a drain of the redundant memory cell, and a redundant ground line electrically connected to a source of the redundant memory cell, and the peripheral circuit region comprising a main memory ground line decoder electrically connected to the main ground lines in the main memory array region, a redundant memory ground line decoder electrically connected to the redundant ground lines in the redundant memory array region, and at least one first signal pass line, at least one second signal pass line, and two ends of each of the signal pass lines being electrically connected to the main memory ground line decoder and the redundant memory ground line decoder respectively, the controlling method comprising:  
while the main memory ground line decoder addresses a common ground line electrically connected to the common doped region, the main memory ground line decoder passes a signal to the redundant memory ground line decoder through the first signal pass line to select the common ground line and each of the sub-decoders and to generate equal-potential output; and  
while the redundant memory ground line decoder addresses the common ground line, the redundant memory ground line decoder passes a signal to the main memory ground line decoder through the second signal pass line to select the common ground line and each of the sub-decoders and to generate equal-potential output.

[c20]

20. A controlling method of a non-volatile memory having a virtual ground array structure, the non-volatile memory comprising a main memory array region, a redundant memory array region connected to the main memory array region, a peripheral circuit region, and a common doped region positioned between the

main memory array region and the redundant memory array region, the main memory array region comprising at least one main memory cell, a main bit line electrically connected to a drain of the main memory cell, and a main ground line electrically connected to a source of the main memory cell, the redundant memory array region comprising at least one redundant memory cell, a redundant bit line electrically connected to a drain of the redundant memory cell, and a redundant ground line electrically connected to a source of the redundant memory cell, and the peripheral circuit region comprising a main memory bit line decoder electrically connected to the main bit lines in the main memory array region, a redundant memory bit line decoder electrically connected to the redundant bit lines in the redundant memory array region, and at least one first signal pass line, at least one second signal pass line, and two ends of each of the signal pass lines being electrically connected to the main memory bit line decoder and the redundant memory bit line decoder respectively, the controlling method comprising:

while the main memory bit line decoder addresses a common bit line electrically connected to the common doped region, the main memory bit line decoder passes a signal to the redundant memory bit line decoder through the first signal pass line to determine a potential of the common bit line and to generate an open-circuit between the common bit line and the redundant memory bit line decoder; and

while the redundant memory bit line decoder addresses the common bit line, the redundant memory bit line decoder passes a signal to the main memory bit line decoder through the second signal pass line to determine a potential of the common bit line and to generate an open-circuit between the common bit line and the main memory bit line decoder.

[c21]

21. A controlling method of a non-volatile memory having a virtual ground array structure, the non-volatile memory comprising a main memory array region, a redundant memory array region connected to the main memory array region, a peripheral circuit region, and a common doped region positioned on a border between the main memory array region and the redundant memory array region, the main memory array region comprising at least one main memory

cell, a main bit line electrically connected to a drain of the main memory cell, and a main ground line electrically connected to a source of the main memory cell, the redundant memory array region comprising at least one redundant memory cell, a redundant bit line electrically connected to a drain of the redundant memory cell, and a redundant ground line electrically connected to a source of the redundant memory cell, and the peripheral circuit region comprising a main memory bit line decoder electrically connected to the main bit lines in the main memory array region, a redundant memory bit line decoder electrically connected to the redundant bit lines in the redundant memory array region, and at least one first signal pass line, at least one second signal pass line, and two ends of each of the signal pass lines being electrically connected to the main memory bit line decoder and the redundant memory bit line decoder respectively, the controlling method comprising:

while the main memory bit line decoder addresses a common bit line electrically connected to the common doped region, the main memory bit line decoder passes a signal to the redundant memory bit line decoder through the first signal pass line to select the common bit line and each of the sub-decoders and to generate equal-potential output; and

while the redundant memory bit line decoder addresses the common bit line, the redundant memory bit line decoder passes a signal to the main memory bit line decoder through the second signal pass line to select the common bit line and each of the sub-decoders and to generate equal-potential output.

[c22]

22. A non-volatile memory positioned on a substrate of a semiconductor wafer, the non-volatile memory comprising:

a main memory array region comprising at least one main memory cell;

a redundant memory array region connected to the main memory array region, the redundant memory array region comprising at least one redundant memory cell;

a common doped region positioned between the main memory array region and the redundant memory array region and commonly used by the main memory cell and the redundant memory cell that are adjacent to the common doped region; and

a peripheral circuit region comprising at least one decoder.

[c23] 23. The non-volatile memory of claim 22 wherein the decoder comprises:  
a main memory decoder;  
a redundant memory decoder; and  
a common decoder.

[c24] 24. The non-volatile memory of claim 23 wherein the common decoder is a common ground line decoder.

[c25] 25. The non-volatile memory of claim 23 wherein the common decoder is a common bit line decoder.

[c26] 26. A non-volatile memory positioned on a substrate of a semiconductor wafer, the non-volatile memory comprising:  
a main memory array region comprising:  
at least one main memory cell, the main memory cell comprising a main source and a main drain positioned in the substrate of the semiconductor wafer;  
at least one main bit line, the main bit line being electrically connected to the main drain of the main memory cell; and  
at least one main ground line, the main ground line being electrically connected to the main source of the main memory cell;  
a redundant memory array region connected to the main memory array region, the redundant memory array region comprising:  
at least one redundant memory cell, the redundant memory cell comprising a redundant source and a redundant drain positioned in the substrate of the semiconductor wafer;  
at least one redundant bit line, the redundant bit line being electrically connected to the redundant drain of the redundant memory cell; and  
at least one redundant ground line, the redundant ground line being electrically connected to the redundant source of the redundant memory cell, wherein a common doped region is commonly used by the main memory array region and the redundant memory array region; and  
a peripheral circuit region comprising at least one decoder.

[c27] 27. The non-volatile memory of claim 26 wherein the decoder comprises:  
a main memory ground line decoder electrically connected to the main ground  
lines in the main memory array region;  
a redundant memory ground line decoder electrically connected to the  
redundant ground lines in the redundant memory array region; and  
at least two signal pass lines, two ends of each of the signal pass lines being  
electrically connected to the main memory ground line decoder and the  
redundant memory ground line decoder, respectively.

[c28] 28. The non-volatile memory of claim 27 wherein the decoder further comprises  
a common ground line decoder.

[c29] 29. The non-volatile memory of claim 26 wherein the common doped region is  
used as the main source and the redundant source formed between the main  
memory array region and the redundant memory array region.

[c30] 30. The non-volatile memory of claim 26 wherein the decoder comprises:  
a main memory bit line decoder electrically connected to the main bit lines in  
the main memory array region;  
a redundant memory bit line decoder electrically connected to the redundant bit  
lines in the redundant memory array region; and  
at least two signal pass lines, two ends of each of the signal pass lines being  
electrically connected to the main memory bit line decoder and the redundant  
memory bit line decoder, respectively.

[c31] 31. The non-volatile memory of claim 30 wherein the decoder further comprises  
a common bit line decoder.

[c32] 32. The non-volatile memory of claim 26 wherein the common doped region is  
used as the main drain and the redundant drain formed between the main  
memory array region and the redundant memory array region.